RECONSIDERING FORD'S HIGHLAND PARK ASSEMBLY LINE: NEW DATA VS. OLD IDEAS

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INTRODUCTION

Ford's Highland Park assembly line created an archetype used in production management ever since. Analysis of new data reassesses its impact to challenge ideas about its development, use and effects. Assembly lines are perceived as rigid, but Ford started without an established theory, and had to accommodate product characteristics, labor capabilities and processes. The assembly line was not deliberately developed as part of a ***planned*** strategy for achieving mass production but was an ***experimental*** groping towards that objective. Past data has not provided sufficient detail for investigating the line's development: thinking about Ford's systems has depended on what Ford said publically about it. More problematically, current understanding also projects modern practices onto the historic systems: assuming that they ***were*** used as modern ones ***are*** used. This may be biased or unrealistic.

NEW DATA

Nevins & Hill's (1954) history of Ford provides annual data for cars produced and staff that previous studies have used. New data has been unearthed in Ford's monthly accounting statements. Raff (1991, 2003) found some of this data in court records and considers it an "Ur source". I found the originals in Ford Motor Company's archives: monthly reports with data on sales, employee numbers with direct and indirect labor hours used. This shows what happens by month rather than accumulated into annual totals that obscure variations ***within*** each year. This data is consistent with Nevins & Hill (1954: 644) with only trivial differences for most years.

ANALYSES

The new data allow month by month changes in output and inputs to be observed more clearly. Figure 1 shows 12 month centered moving averages for direct, indirect and total hours per car showing productivity trends over the whole time the Model T was produced.

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The data show improvements in labor productivity from the Model T's introduction in 1908 until production ceased in 1927. It shows improvements before the line's development, as for any new product, productivity initially improved considerably. The company introduced job grading and wage scales in 1912 and reduced the power of supervisors so that decisions on employment, wages and discipline were standardized. (Meyer, 1981) Ford increased

productivity to one car per employee per month between 1911 and 1913. Williams, et al. (1993) saw this as challenging the line's mythical status, arguing that these developments had a greater absolute impact. Between 1913 and mid-1915 Ford reduced labor by another one third. However, this cannot unambiguously be ascribed to the line. In January, 1914 Ford initiated the $5 day, doubling the average wage. There was no linked improvement in labor productivity but Meyer (1981) believes it reduced labor turnover, improved absenteeism and time-keeping along with industrial discipline and loyalty.

In the early 1920s the automobile market became more competitive and Ford wanted to reduce costs. The labor market also reflected these changes, so workers had fewer alternatives. In January, 1921 the factory was shut down to be completely reorganized. When reopened it employed one third fewer staff and the line was run more quickly. (Sward, 1948) From then on Ford kept speeding the line's pace to drive productivity higher.

Despite widespread knowledge (Gartman, 1986) of Ford's actions in 1921 and later, previous studies have restricted analyses to the 1912-1915 period. This is myopic.

OLD IDEAS

The new data provide insight into much more than the measurement of labor productivity. Several popular ideas about the line's introduction and use can be critically reassessed.

Idea 1: Sales Stabilized *Before* the Assembly Line Started

The most unexpected aspect of the new data was the ***sales variability***. This detail was unavailable in annual data. Figure 2 shows Ford closely matched production levels to highly variable monthly sales (Note: Production after mid-1914 started to be allocated to branches). The correlation of .98 shows they were tightly linked. O'Brien (1997) asserts that Ford's monthly output could only match monthly sales if they actively monitored sales and adjusted production ***during*** the month. Figure 2 shows inventories were not used counter-cyclically (the correlation coefficients are positive and relatively high at .82 for sales and .79 for production) to stabilize production by absorbing sales fluctuations.

Ford developed the line under conditions for which most modern operations managers would consider it unsuitable: "The term mass demand must be qualified; in particular, we must consider not only the level of demand, but also the continuity. …demand is both high and reasonably continuous." (Wild, 1972: 14) The critical question is: How did Ford do what modern managers would consider very difficult, if not impossible?

Ford was able to match production to demand by using ***multiple*** assembly lines. As sales fluctuated Ford varied the number of lines used. Unskilled staff and sub-divided work facilitated this, the lines could be idle when sales were low and used when demand rose. Klann (1955: 84) says some lines were "temporary" used for "…only 2 or 3 weeks at a time." In addition, the Ford Times (1914) describes the line's use: "…no matter whether the factory is turning out 1000 or 2000 cars per day the time of building an individual car is in no way affected…. When it's desired to build more cars, more conveyors are put into operation, or those in service are run a greater number of hours each day, that's all."

This flexibility is a revelation that overturns previous thinking. It is well supported by the accounting data found, with mutually consistent sales, production, inventories, staff numbers and hours worked all supporting the analysis. In addition, the Ford Times (1914) provides contemporary documentation; and Klann (1955) provides personal testimony to its flexible usage. A technical analysis shows these reports to be consistent with one another and production

records. The official history (Nevins & Hill, 1954) affirms Ford's use of multiple lines. Current research (O'Brien, 1997; Raff, 2003) recognizes the close links between production and sales.

Idea 2: An Unchanging Product

The symbiotic relationship between the Model T as product and the moving assembly line as process makes them inseparable. Ford's output in the mid-1920s was twenty times greater than in 1912. The assembly line with its standardized processes and the standardized product with its standardized parts enabled production to keep pace with sales. Ford continuously improved both the product and production processes, although the Model T hardly seems to have changed. This superficial product continuity obscures non-trivial variations in the Model T's production: the ***different body styles***. If Ford's product mix was assessed as a modern manufacturer's would be, a different picture may emerge from the common view that Ford did not respond to changing customer demands.

Idea 3: Assembly Lines are Expensive

Raff (2003) observes that assembly lines are generally assumed to be capital intensive. The new data provide details on Ford's use of fixed and working capital. Hounshell (1984) notes Ford invested substantially in their factory prior to implementing the assembly line. Williams, et al. (1993) assert that these investments created a capacity that pressured Ford's assembly abilities. The line was Ford's response to those difficulties. The relatively smaller investments after mid-1913 imply that materials handling equipment and the lines themselves imposed low capital demands. A critical distinction is necessary between the capital demands imposed by ***production***, concerned with transformation processes such as machining, drilling, milling, welding, etc.; and ***assembly*** lines, concerned with putting those manufactured components together. Indeed, Klann's (1955) observation that one assembly line could be used for just a few weeks during the year implies that these were inexpensive to set up, and the costs in changing staff levels in starting and stopping them were low.

Idea 4: Labor Cost Reductions Drove Price Reductions

Ford (1924, 1926) asserted that price reductions followed efficiency gains. These claims cannot be investigated with Nevins & Hill's (1954) data. In the early years, average revenues were lower than the base price because dealers received a proportion of the revenue. Then later, as customers bought more expensive body styles and extra-cost options average revenues increased to match and then exceed the base price. Although price was important when the Model T was first introduced, in later years the basic Model T's base price was more significant as a ***marketing*** tool. The company then sold few basic Model Ts, increasing its revenues with options and shifting demand to its more expensive body styles.

Ford's price reductions came not from improved labor productivity but from reductions in materials costs. These declined from 1909 through the start of the First World War when they rose significantly, probably due to competing war-time demands. After 1921, labor or material savings do not appear to have affected pricing decisions. The base model was no longer the market leader and consumer decision making had evolved to consider more than base prices.

Idea 5: Deskilling was the Line's Raison d'être

Yes, but not to save costs. My counter-argument is that the workforce available in 1914 Detroit induced Ford to redesign jobs and production systems to utilize most effectively those

people most readily available. Only in Ford's earliest days does it appear that cars were built by skilled workers because assembly then also required custom fitting of components. With the advent of the Model T with its use of standardized parts such skills were no longer required in ***assembly***. Employees with such skills could be used better elsewhere, in ***production***. Given the perception that skilled workers were scarce (Hounshell, 1984) there would have been opportunities for their more rewarding employment in those areas. Deskilling as a strategy for increasing output would be counter-productive if it drove skilled workers away. The data that the ***line*** was flexibly used implies that the whole ***factory*** was as well, thus production activities varied too to accommodate demand. Deskilling as a response to ***varying*** loads was achieved by Ford's use of "farmer machines"- dedicated equipment that required little training or skill.

Ford's unforced simultaneous introduction of the $5 day renders absurd the idea that the line was all about cost savings. Meyer (1981) suggests the $5 day was intended to reconcile workers to the greater demands the line imposed. Alternatively, the new data show a new aspect: higher wages compensated for the ***uncertainty*** of employment.

Prior to introducing the assembly line Ford would have employed unskilled staff and have recognized their availability and characteristics. Not only were these employees unskilled, they also suffered from numerous other deficiencies. Many more were migrants or immigrants with agrarian backgrounds aggravated by poor communications abilities and culture conflicts. With such a poor workforce available Ford would benefit if they could structure work so that these people could be readily employed when and as required. By extremely simplifying work Ford reduced training requirements to a minimum, thus staff could be readily acquired. And their use then also depended on limited interaction between workers within and between workstations so communications too would be kept to a minimum.

The critical issue for Ford at that time was expanding production to meet increasing demand: the line enabled unskilled and otherwise unemployable people to fulfil that requirement.

CONCLUSIONS

The new data first allow a reassessment of the line's impact on labor productivity. It confirms scholarship on the line's initial effects on productivity and on costs, but extends the analysis to the 1920s when management used the line to increase productivity further. The trends provide a clearer perspective on how labor productivity evolved over the Model T's life.

The detailed data provide a finer measure than previously available- one that allows the extreme seasonality in Ford's sales and production to be observed, with notable ramifications for many contemporary ideas about that historic system. The sales variability provides a rationale for the line's development beyond simple cost savings- capacity could easily expand and contract using readily available workers with few industrial or communication abilities.

Ford's (1926; Nevins & Hill, 1954) dictum "History is bunk…" was grounded in his belief that past experience ***restricted*** what people would do. His flexible use of assembly lines, an approach that later came to signify an inflexible system, is sublimely ironic.

REFERENCES

REFERENCES AVAILABLE FROM THE AUTHOR

FIGURE 1

TOTAL MAN HOURS PER CAR

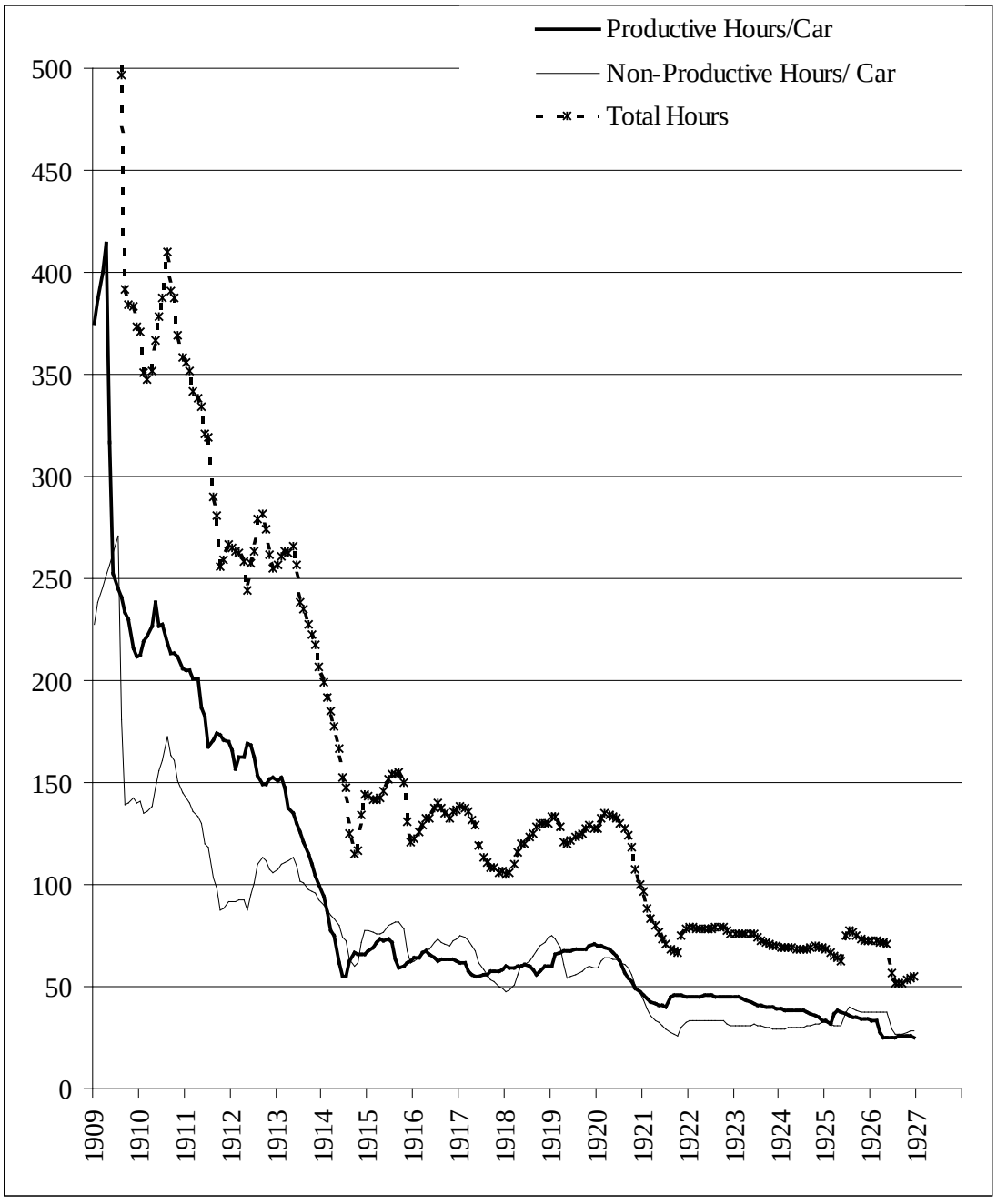

FIGURE 2

PRODUCTION, SALES & INVENTORIES

January, 1913- December, 1918